SECTION 2

QUALITY ASSURANCE AND QUALITY CONTROL

2.1 Introduction

2.1.1 A strong quality assurance (QA) program and effective quality control (QC) procedures are needed for operating an adequate macroinvertebrate bioassessment or monitoring laboratory to ensure that all data produced are valid and of known quality. The term "quality assurance" refers to the quality control functions and involves the totally integrated program for ensuring the reliability of monitoring data; the term "quality control" refers to the routine application and procedures for obtaining prescribed standards of performance and for controlling the measurement process (USEPA, 1978). Quality assurance programs have two primary functions in a macroinvertebrate laboratory. First, the program should continually monitor the reliability of the data generated to determine the accuracy, precision, completeness, comparability, and representativeness of the data. The second function is the control of the quality of the data so as to meet the requirements for reliability that the program demands. Quality assurance and control must be a continuous process that includes all aspects of the program, including field collection and preservation, sample processing, and data analysis; otherwise the data generated may not be reliable and useful for decision making and the results will be of little use in establishing the biological integrity of the water body under study. In order to support the operation of a consistent plan, the persons responsible for QA should consult the EPA Quality Assurance manual (USEPA, 1984a). All EPA QA programs should be based on USEPA order 5360.1 (USEPA, 1984b) which describes the policy, objectives and responsibilities of all USEPA program and regional offices.

2.1.2 Components of the QA program (USEPA, 1979) should include the following:

2.1.2.1 Collection, preservation and analysis of all samples should follow approved methodology.

2.1.2.2 Sampling equipment, flow measuring devices, and other measuring instruments such as pH, DO, and conductivity meters should be calibrated according to manufacturer's instructions, and documented.

2.1.2.3 Assurance that representative samples are collected (See Section 4, Selection of Sampling Sites).

2.1.2.4 Determination of precision of sampling and analysis procedures.

2.1.2.5 Use of replication in all phases of the sampling and analysis program.

2.1.2.6 Participation in interlaboratory investigations and use of quality control samples.

2.1.2.7 Accurate and timely recording, maintenance, and storage of data in a log book, computer, or other data storage and retrieval system.

2.2 Data Quality Objectives (DQOs)

2.2.1 A full assessment of the data quality needed to meet the study objectives should be made prior to preparation and implementation of the QA plan. Data quality is a measure or description of the type and amount of error associated with a set of data. Determination of data quality is accomplished through the development of data quality objectives (DQOs), which are statements of the level of uncertainty a decision-maker is willing to accept or the quality of the data needed to support a specific environmental decision or action. Both qualitative and quantitative descriptors of data quality must be considered in order to determine whether data are appropriate for a particular application. Data quality objectives are target values for data quality and are not necessarily criteria for the acceptance or rejection of data.

2.2.2 Data quality objectives are developed in three stages. During the first stage, the decision-maker determines what information is needed, reasons for the need, how the information will be used, and specifies time and resource constraints. The second stage involves the technical staff and decision-maker interacting to establish a detailed and clarified specification of the problem, how the information will be used, any constraints imposed on the data collection, and what limitations of the information will be acceptable. The third stage involves the analysis of possible approaches to collection and analysis of the data and a determination of the quality of the data that can be expected to result from each approach. The best approach is selected based on the criteria agreed upon in the second stage. It may be necessary to modify the objectives of the study during the development of these DQOs. Details for developing DQOs are described in two U.S. Environmental Protection Agency documents (USEPA, 1984c and 1986) available from the Quality Assurance Management Staff, Office of Research and Development, Washington, DC 20460.

2.2.3 After the final DQOs are established, the detailed project QA plan should be finalized stating specific quantitative and qualitative data quality goals and QC procedures that will be used to control and characterize error (USEPA, 1980). The goals based on the DQOs will be the criteria for measuring the success of the QA program.

2.2.4 The Quality Assurance Management Staff, Office of Modeling, Monitoring Systems, and Quality Assurance, is responsible for providing guidance for the inclusion of DQOs in quality assurance program and project plans, and for providing guidance to the regions on the application of the DQOs development process. The EPA regional offices are responsible for ensuring that state QA program and project plans conform with grant requirements specified in 40 CFR Part 30, and for assisting the states in developing DQOs requirements that meet state needs.

2.2.5 Regional and state laboratories or monitoring personnel in need of assistance in preparing Quality Assurance Project Plans or development of DQOs for bioassessment projects can contact personnel of the Aquatic Biology Branch in the Quality Assurance Research Division, Environmental Monitoring Systems Laboratory-Cincinnati, for assistance (FTS 684-8114 or COML 513-533-8114, FAX FTS 684-8181 or COML 513-533-8181).

2.3 Facilities And Equipment

2.3.1 Laboratory and field facilities and utility services must be in place and operating consistent with their designed purposes so that quality environmental data may be generated and processed in an efficient and cost-effective manner. Suitability of the facilities for the execution of both the technical and QA aspects of the study should be assessed prior to initiation of the study. Adequate space, lighting, temperature, noise levels, and humidity should be provided. Satisfactory safety and health maintenance features must also be provided (see Section 3, Safety and Health).

2.3.2 Equipment and supplies necessary to adequately collect, preserve and process biological samples must be available and in good operating condition. See Appendix E for a list of recommended equipment and supplies.

2.3.2 To ensure data of consistently high quality, a plan of routine inspection and preventive maintenance should be developed for all facilities and equipment. All inspections, calibrations, and maintenance must be documented in individually bound notebooks. This documentation should include detailed descriptions of all calibrations performed, adjustments made, and parts replaced and each entry should be signed and dated.

2.3.3 Taxonomists and aquatic biologists who are capable of identifying organisms are expected to have at their disposal adequate taxonomic references to perform the level of identification required. See Section 8, Taxonomic Bibliography, for a list of selected taxonomic references. Aquatic biologists should check this list and obtain those references that will be needed for the identification of specimens to the lowest taxonomic level possible.

2.3.4 Representative specimens of all taxa identified should be verified by a specialist who is a recognized authority in that particular taxonomic group. These specimens should be properly labeled as reference or voucher specimens, including the name of the verifying authority, permanently preserved, and stored in the laboratory for future reference.

2.4 Calibration, Documentation, and Record Keeping

2.4.1 Quality assurance plans should contain mechanisms for demonstrating the reproducibility of each measuring process. Regular calibration of instruments, proper documentation, and permanent record keeping are essential aspects of such plans.

2.4.2 Each measuring device must be calibrated before each use according to

the manufacturer's instructions, and routine checks using National Institute of Standards and Technology, or other standards of known accuracy, should be made to demonstrate that variables are within predetermined acceptance limits. Permanent records giving dates and details of these calibrations and checks must be kept. Documentation is necessary to identify each specific measuring device, where and when it is used, what maintenance was performed, and the dates and steps used in instrument calibration. Each sample collected should also be documented by assigning a unique identification number and label (See Section 6, Sample Processing). Data should be documented to allow complete reconstruction, from initial field record through data storage system retrieval.

2.4.3 Whenever samples are collected to be used as evidence in a court of law, it is imperative that laboratories and field operations follow written chain-of-custody procedures for collecting, transferring, storing, analyzing, and disposing of the samples. The primary objective of chain-of-custody procedures is to create written record which can be used to trace the possession of the sample from the moment of collection through the introduction of the analytical data into evidence. Explicit procedures must be followed to maintain the documentation necessary to satisfy legal requirements. All survey participants should receive a copy of the study plan and be knowledgeable of its contents prior to implementing the field work. A presurvey briefing should be held to reappraise all participants of the survey objectives and chain-of-custody procedures. After all chain-of-custody samples are collected, a debriefing should be held in the field to check adherence to chain-of-custody procedures. Chain-of-custody procedures are detailed in three USEPA manuals (USEPA, 1974, 1982, and 1990).

2.4.4 Field and laboratory personnel should keep complete and permanent records of all conditions and activities that apply to each individually numbered sample sufficient to satisfy legal requirements for any potential enforcement or judicial proceedings. All field and laboratory data sheets should be dated and signed by the sampler and analyst, respectively. Notebooks, data sheets, and all other records that may be needed to document the integrity of the data should be kept permanently filed in a safe and fireproof place.

2.5 Qualifications and Training

2.5.1 All personnel need to have adequate education, training, and experience in the areas of their technical expertise and in QA to fulfill their designated responsibilities. Because no formal academic programs in research QA exist, most QA experience will have to be acquired through on-the-job training.

2.5.2 At least one professional biologist with training and experience in biological sampling methods and macroinvertebrate identification should be on the staff and should be personally involved in the field work as well as the laboratory analysis of the samples. Statistical expertise should be readily available and consulted during every phase of the project.

2.5.3 Management should periodically assess the training needs of all

personnel engaged in QA and recommend and support their participation in appropriate and relevant seminars, training courses, and professional meetings. Biologists and technicians should be expected to participate regularly in evaluation and/or certification programs where appropriate.

2.5.4 The laboratory should have on file an up-to-date resume for each person who is responsible for the analysis, evaluation and reporting of biological data.

2.6 Standard Operating Procedures (SOPs)

2.6.1 Each laboratory must define the precise methods to be used during each step of the sample collection, analysis, and data evaluation process. These written procedures become the standard operating procedures (SOPs) describing the operation of the laboratory. Standard operating procedures for a macroinvertebrate laboratory should describe in stepwise language, easily understood by the potential user, the sampling methodology, details of preservation and labeling the samples, use of taxonomic keys, use and calibration of measuring instruments, replication and QC requirements, sample custody and handling procedures, and data evaluation and handling. The SOPs should include a listing of the taxonomic keys and references that should be used for each level of identification required and for each taxonomic group. It should provide an outline of the steps to be taken to assure the quality of the data.

2.6.2 The SOPs should stress the need for the traceability of the samples. At a minimum it should specify that each sample be assigned a unique identification number and be properly labeled with the sample number, sampling location, and name of the collector. It should describe procedures to ensure that each sample collected, as accurately and precisely as possible, represents the community sampled.

2.6.3 The SOPs should be approved by the proper authority and should be easily accessible to personnel for referral.

2.6.4 The laboratory SOPs should be followed as closely as possible. Any deviations should be documented as to the reason for the deviation and any possible effect the deviation might have on the resulting data.

2.7 Literature Cited

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